Parameters of SLV Triple Point of Graphite

A.Yu. Basharin and V. E. Fortov
High Energy Density Research Center for High Temperatures
Russian Academy of Sciences
Moscow, Russia

The discrepancy of experimental data on parameters of a triple point of graphite is mar-ked. Some researchers register equilibrium temperature T_{tp} at a level 4000 K (P_{tp} in the area 0.1 MPa), others–at 5000 K (10 MPa), using the same technique. According to a "boiling point" method T_{tp} is determined as the "plateau" temperature on the heating (cooling) thermogram of a graphite sample, and P_{tp} as the minimal pressure at which traces of liquid carbon are formed. In this report an attempt is made to find out the reason of the observed divergence. The report contains the investigation of two variants of the laser heating thermogram of highly oriented graphite by the pulse of focused Nd: glass laser (700 μs, W < 0.5 MW/cm^2) in He atmosphere (P_0 = 0.1 -16 MPa). In the variant (I) heating of a sample was made perpendicularly to its surfaces through a quartz plate (gap 12 mm). In the variant (II) the gap varied within the limits of 20-100 μm. The brightness temperature of a sample T^{br} and laser power during heating were measured.

Results of temperature measurements. In the variant (I) "plateaus" occurred only on the sample cooling thermograms at a level 3400 - 4000 K (ε_λ was assumed to be 0.64) depending on P_0 and W through ≈ 500 μs after ending a laser pulse. Comparison to temporary development of the vapor zone luminescence has shown that the "plateau" formation is accompanied by vapor condensation in the gas volume. In the variant (II) well-reproduced "plateaus" were registered at a stage of heating with T^{br}, depending only on P_0. The observed dependence P(T) corresponds to the literature data for equilibrium vapor pressure. In addition to the boiling "plateau" at P_0 > 15 MPa one can register also the melting "plateau" at a level T_m = 4750 ± 100 K.

Graphite structure. Preliminary analysis shows that the heating at P_0 < 5 MPa (II) is accompanied by the occurrence of carbon particles of micron sizes (deposited on quartz). At P_0 > 5 MPa a translucent film is formed on quartz, and the particles can be seen on the film periphery. Large (up to 50 μ in diameter) single drops of graphite were found also in the heating zone at P_0 > 15 MPa.

Conclusions. Observed T_m, according to our P(T) data, corresponds to P_0 ≈ 5 MPa. Alterations of the besieged graphite structure on quartz, observed by the authors, also refer to this pressure. We show that the valid parameters of the triple point of graphite are T_{tp}=4750 ± 150 K, P_{tp} =5 ± 1 MPa. From this point of view, measurements on fixing large drops of graphite give the overestimated result on P_{tp}, and pair condensation in alarge He volume above a sample result in an underestimated T_{tp}.